Pelvic Drop Category (sex-specific case-based quartile)	Cases N = 106 n (%)	Controls N = 106 n (%)	OR (95% CI)
Lowest	26 (24.5)	46 (43.4)	1.0 (Reference)
2nd	26 (24.5)	26 (24.5)	1.5 (0.7, 3.2)
3rd	28 (26.4)	22 (20.8)	1.9 (0.9, 3.8)
Highest	26 (24.5)	12 (11.3)	2.9 (1.3, 6.2)
p for trend			0.008

178
MUSCLE CO-ACTIVATION, KNEE JOINT KINEMATICS, AND GROUND REACTION FORCES ARE ALTERED IN THE OPERATED LEG OF MENISCECTOMIZED PATIENTS AT HIGH RISK OF KNEE OSTEOARTHRITIS

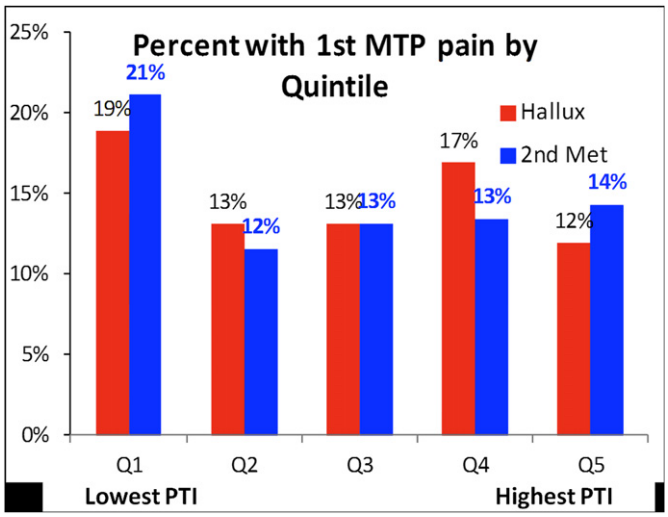
J.B. Thorlund, J. Damgaard, E.M. Roos, P. Aagaard. *Inst. of Sports Sci. and Clinical Biomechanics, Univ. of Southern Denmark, Odense M, Denmark*

Purpose: Every other meniscectomized patient develop knee osteoarthritis (OA) 10-15 years after surgery. Thus, meniscectomized patients constitute a useful model to study changes in neuromuscular activity and knee joint biomechanics, which are factors suggested to play a role in OA development.
Recently, we were unable to detect differences in neuromuscular activity and knee joint kinetics/kinematics between meniscectomized patients and controls during stair descent. Furthermore, only modest leg-to-leg differences were observed between the operated and contra-lateral leg of the patients. More demanding motor tasks may be needed to detect early changes in knee joint kinetics/kinematics and neuromuscular activity in meniscectomized patients at high risk of knee OA.
The aim of this study was therefore to investigate knee joint kinematics, ground reaction force (GRF) kinetics and level of muscle co-activation during a standardized forward lunge maneuver in meniscectomized patients at high risk of knee osteoarthritis. We hypothesized that patients would display increased levels of muscle co-activation along with reduced knee joint range of motion (ROM) and altered GRF kinetics in the operated compared to the contra-lateral leg.
Methods: Patients: Twenty-two patients meniscectomized uni-laterally for a medial meniscal tear in the posterior half of the meniscus (15 men and 7 women, 45.4±5.1 years, 174.3±7.1 cm, 77.3±15.4 kg, BMI 25.4±kg/m2, values are mean±SD) were investigated during a standardized forward lunge with synchronous electromyography (EMG), goniometer and force plate recording.
In the analyses we focused on three different phases of the forward lunge; the loading phase (foot-strike to 80% peak GRF), the unloading phase (80% peak GRF to toe-off) and mean of the entire stance phase (foot strike to toe-off).
Knee joint range of motion (ROM): Knee joint ROM during the loading phase (ROMload), unloading phase (ROMunload) and from foot strike to peak knee flexion (ROMpeakflex) were measured using a flexible electrogoniometer.
Ground reaction forces (GRF): The vertical GRF signal during the forward lunge was used to calculate the rate of loading (Loadslope), rate of unloading (Unloadslope) and average magnitude of GRF during the entire stance phase (GRFmean).
Co-activation: Thigh muscle co-activation in the above phases of the forward lunge was quantified using normalized EMG signals obtained in the vastus lateralis (VL), vastus medialis (VM), biceps femoris (BF) and semitendinosus (ST) muscles.
Statistics: Paired t-test with 0.05 level of significance was used to assess differences between the operated and contra-lateral leg of the patients.
Results: All results are reported as mean±SE. Consistent differences were observed between the operated leg and contra-lateral leg during the impact phase (loading phase) of the forward lunge. These differences were manifested as increased levels of muscle co-activation (38.0±4.0 vs. 30.1±3.1 %MVC, p=0.02), reduced ROM (23.4±2.9 vs. 29.7±2.7 degrees, p=0.01) and a higher loading rate (Loadslope) (985±160 vs. 696±82 %BW s-1, p=0.01). Furthermore, ROMpeakflex was reduced in the operated compared with the contra-lateral leg (59.4±2.3 vs. 64.9±2.0 degrees, p=0.01). No differences were observed in ROMunload, Unloadslope or muscle co-activation during the unloading phase. In addition, no differences were observed in GRFmean and average muscle co-activation during the entire stance phase.
Conclusions: The findings of increased muscle co-activation, reduced ROM and increased rate of loading during the loading phase between the operated and contra-lateral leg support the hypothesis that meniscectomized patients demonstrate early modulations in knee joint kinetics, kinematics and neuromuscular activity in the operated leg. Future studies should include more demanding motor tasks than stair walking. Representing such a task, the forward lunge test appears to provide a sensitive approach to identify leg-to-leg differences in relevant neuromuscular and biomechanical variables in middle-aged patients at risk of OA.

179
ARE PRESSURE TIME INTEGRAL AND CUMULATIVE PLANTAR STRESS RELATED TO 1ST METATARSOPHALANGEAL JOINT PAIN: THE MULTICENTER OSTEOARTHRITIS STUDY

S. Rao [1], K. Gross [2], J. Niu [2], M. Nevitt [3], B. Lewis [4], J. Torner [5], J. Hietpas [6], D. Felson [2], H. Hillstrom [7]. [1] *New York Univ., New York, NY;* [2] *Boston Univ., Boston, MA, USA;* [3] *Univ. of California, San Francisco, CA, USA;* [4] *Univ. of Alabama at Birmingham, Birmingham, AL, USA;* [5] *The Univ. of Iowa, Iowa City, IA, USA;* [6] *Univ. of California San Francisco, San Francisco, CA, USA;* [7] *Hosp. for Special Surgery, New York, NY, USA*

Purpose: Pain at the 1st metatarsophalangeal (MTP) joint is one of the key symptoms of 1st MTP osteoarthritis (OA). First MTP OA is the most common form of degenerative joint disease in the foot, and affects 35-60% of adults over 65 years. The incidence and progression of OA has been linked to mechanical stress. However, few studies have assessed plantar stress in individuals with foot pain. The purpose of this study was to examine the relationship between plantar stress over a step, cumulative plantar stress over a day and 1st metatarsophalangeal (MTP) joint pain among older adults.
Methods: Plantar stress and 1st MTP pain were assessed within the Multicenter Osteoarthritis (MOST) study. The MOST study comprises a community-based sample of men and women who either have, or are at risk for, knee OA. Individuals with unilateral or bilateral total knee replacement, a prosthetic foot or those requiring an assistive device (eg. cane or walker) were excluded. All included participants were asked if they had pain, aching or stiffness at the 1st MTP joint on most days for the past 30 days on a pain diagram. Plantar loading was quantified as participants walked on a pedobarograph (Novel Electronics, St Paul, MN). Five trials per foot were acquired during self-selected walking speed. Regions of interest (hallux, 2nd metatarsal) were defined (Novel Database, St Paul, MN). Plantar stress over a step was calculated using pressure time integral (PTI), defined as the area under the pressure-time curve throughout stance phase, and expressed in N.s/cm2. Additionally, mean steps per day were obtained (Stepwatch, Oklahoma City, OK). Cumulative plantar stress was calculated as the product of regional PTI and mean steps per day. Quintiles of hallucal and 2nd metatarsal PTI and cumulative plantar stress were generated. The relationship between predictors (PTI, cumulative plantar stress) and the odds ratio of 1st MTP pain were assessed using a logistic regression model that adjusted for age, sex, BMI, knee OA status (no OA vs. OA), and walking speed. We adjusted for the correlation between two feet using GEE.
Results:1693 subjects (58% female, mean (SD) age: 61 (7) years, mean (SD) BMI: 30.3 (5.8) kg/m2, met the inclusion criteria. First MTP pain was reported by 14.7%. Percentage of subjects reporting pain in each quintile are depicted in Fig 1.
Feet in the quintile with the lowest hallux PTI had 2.14 times increased odds of 1st MTP pain (95% confidence interval [95% CI]:3.25-1.42, p<0.01). Feet in the quintile with the lowest 2nd metatarsal PTI had 1.50 times increased odds of 1st MTP pain (95% CI:1.01-2.23, p=0.042). No significant relationships were found between cumulative plantar stress and odds of 1st MTP pain.
Conclusions: The chief findings of our study indicate that lower PTI was modestly associated with increased prevalence of frequent 1st MTP pain at both the hallux and 2nd metatarsal. These findings may suggest that individuals experiencing foot pain adopt an antalgic strategy to avoid exacerbating their foot pain. The reduction in plantar loading may reflect an attempt at pain avoidance. Future longitudinal studies are indicated to examine the long-term consequences of altered plantar load distribution on pain and disability.



180
KNEE OSTEOARTHRITIS SEVERITY ASSESSMENT USING KNEE KINEMATIC DATA CLASSIFICATION

N. Mezghani [1], Y. Ouakrim [1], A. Fuentes [1], N. Hagemeister [1], R. Aissaoui [1], M. Pelletier [2], J. de Guise [1]. [1] *Laboratoire de recherche en imagerie et orthopédie, Montreal, QC, CANADA;* [2] *Ctr. de recherche du CHUM, Montreal, QC, Canada*

Purpose: The modern technology used in gait analysis allows new insights into human gait patterns understanding and offers opportunities to develop automatic objective methods to aid in the diagnosis of musculo-skeletal pathologies such as knee osteoarthritis. The purpose of this study was twofold: (1) develop a classification method to distinguish between knee osteoarthritis (OA) patients and asymptomatic participants using three-dimensional (3D) knee kinematic measurements during gait, and (2) further investigate classification method to discriminate the severity of knee OA in the pathological participants using gait patterns.
Methods: Fourteen asymptomatic participants (AS) and 30 knee osteoarthritis patients (OA) took part in this study. The OA patients were grouped into two OA severity categories according to the Kellgren and Lawrence (KL) scale: KL 1 and KL 2 for one category, and KL 3 and KL 4 for the other. 3D knee kinematic data (flexion/extension, adduction/abduction and internal/external rotation) were recorded while the subjects walked at a self-selected comfortable speed on a on a conventional treadmill. A validated knee marker attachment system (KneeKG^{TM}, Emovi, Canada), was installed on the subject knee to record the 3D kinematics. The kinematic data were normalized for each subject, and the mean pattern was used as a representative gait cycle (for each subject) for the purpose of feature extraction and classification. Features are extracted from the kinematic data pattern to determine the most appropriate sub-cycle for classification. Following this representation data acquisition, we investigated a two-level hierarchical analysis method, one level to discriminate AS participants from knee OA patients, and the other to assess the severity of the disease of the OA patients into two groups (KL1-2 and KL3-4). Classification used the subspace method based on singular value decomposition (SVD). Classification performance is evaluated by cross-validation in terms of accuracy, sensitivity, and specificity. Cross-validation provides a robust evaluation method for estimating the generalization error and classification performance.
Results: Adduction/abduction kinematic data is more discriminating than flexion/extension and internal/external rotation data. For AS/OA classification, the analysis showed that the most discriminating sub-cycle was during the stance phase, more precisely between 10 % and 40% of the gait cycle. The corresponding classification success rate was 93.1%, with 79% sensitivity and 100% specificity. Concerning the knee OA severity assessment into KL1-2 and KL3-4 categories, the classification success rate was 93.2%. This was achieved using frontal kinematic data during the swing phase, more specifically data between 66 % and 100% of the gait cycle.
Conclusions: Our findings show that a knee biomechanical assessment and pattern classification methods not only allows the discrimination of knee OA patients from asymptomatic participants but can also differentiate with high success rate knee OA patients with low KL grade (KL 1-2) from high KL grade (KL 3-4). Results emphasize the potential benefits of a biomechanical assessment in helping diagnose and grade knee OA patients.

181
EFFECTS OF UNSTABLE ROCKER-SOLED SHOES ON KNEE LOAD PARAMETERS IN PEOPLE WITH KNEE OSTEOARTHRITIS

E.G. Madden, C.O. Kean, T.V. Wrigley, K.L. Bennell, R.S. Hinman. *Univ. of Melbourne, Melbourne, Australia*

Purpose: Unstable rocker-soled shoes are relatively new and novel designs to the footwear market. They are promoted to reduce "joint stress", potentially by increasing activity of small intrinsic lower leg muscles. Soles of rocker-soled shoes typically contain a highly compressible material of increased height and curve compared to traditionally designed shoes, theoretically increasing foot/ankle motion in sagittal and frontal planes. To date, there has been minimal investigation of the effects of rocker-soled shoes on knee load in people with knee osteoarthritis (OA). Given that footwear influences the knee adduction moment (KAM) in people with knee OA, and that the KAM is important in disease pathogenesis, an understanding of the effects of rocker-soled shoes on this parameter of knee loading is important. The purpose of this study was to evaluate the effects of rocker-soled shoes on the KAM in knee OA as compared to i) standardised control shoes and ii) barefoot walking.
Methods: Twenty five individuals (15 (60%) female, mean (SD) age 61 (8) years, mean (SD) body mass index 28 (4) kg/m2) with radiographic knee OA (Kellgren and Lawrence grade greater than or equal to 2) and pain on most days were recruited from the community. Participants underwent three-dimensional gait analysis (12-camera VICON, 3 AMTI force plates) under three conditions in random order i) standardised control shoes (Asics Gel Odyssey), ii) rocker-soled shoes (Skecher Shape-up Fitness Junkie (womens) and Skecher Shape-up Motivation (mens)) and iii) barefoot walking. Participants walked at a self-selected normal pace. For each condition, five trials with clean force plate strikes, and average speed within 5% of self-selected pace, were collected. Peak KAM (Nm/Bw*ht%) during the first half of stance, and KAM impulse (Nm.s/BW*ht%), were determined from each trial and averaged. Differences between conditions were examined using repeated measures ANOVA. Where significant results were obtained, post hoc comparisons were performed using Bonferroni post-hoc tests.
Results: Mean (SD) parameters of the KAM across testing conditions are reported in Table 1. Peak KAM was significantly lower when wearing rocker-soled shoes compared to control shoes (p value < 0.001, mean difference (95%CI): -0.28 (-0.45, -0.12)). There was no significant difference between peak KAM recorded in rocker-soled shoes and barefoot walking (p value $= 0.248$, mean difference (95%CI): 0.15 (-0.63, 0.36)). KAM impulse with rocker-soled shoes was not significantly different to that of control shoes (p value $= 0.068$, mean difference (95%CI): -0.33 (-0.68, 0.02)). Both rocker-soled shoes and control shoes recorded significantly higher KAM impulses compared to barefoot (p values< 0.001, < 0.001 respectively). There was no significant difference in speed between conditions.
Conclusions: Peak KAM was reduced in rocker-soled shoes compared to control shoes. Importantly, the peak KAM in rocker-soled shoes was similar to that of barefoot walking. Given that most shoes increase the peak KAM in people with knee OA, the decrease noted with rocker-soled shoes may be beneficial in reducing knee load in this population. These findings are consistent with a recent study which found a reduction in the first peak KAM in an overweight male population. Further research is needed to evaluate safety aspects of these shoes with respect to balance, and their influence on symptoms.